

A Space Weather Event on the Microwave Anisotropy Probe (MAP)

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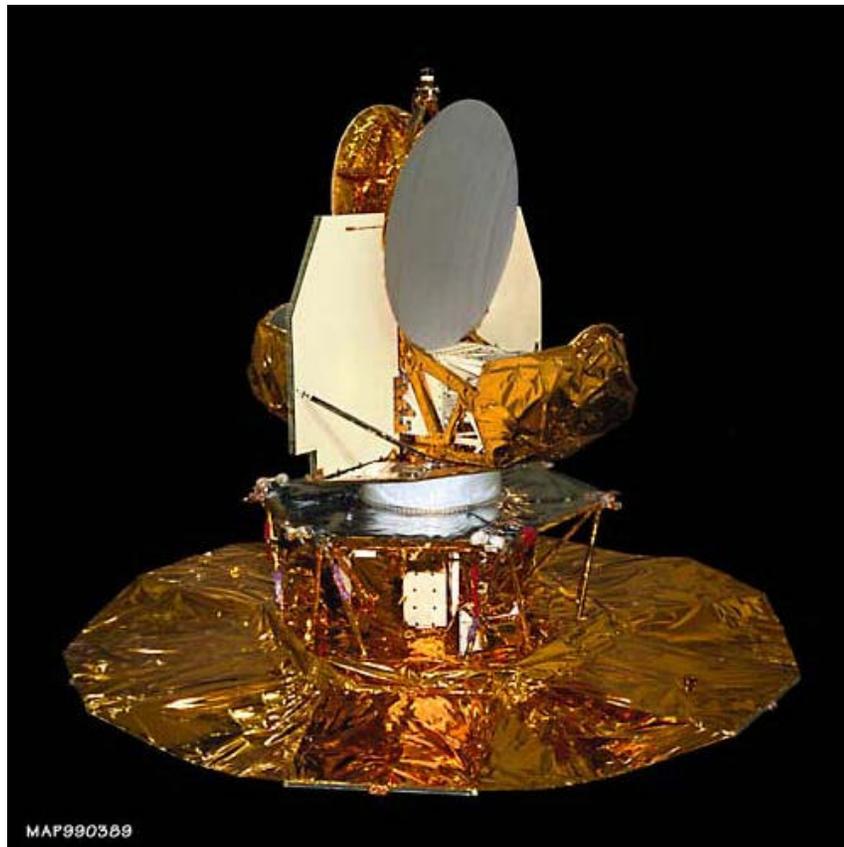
September 19-20, 2002



Outline

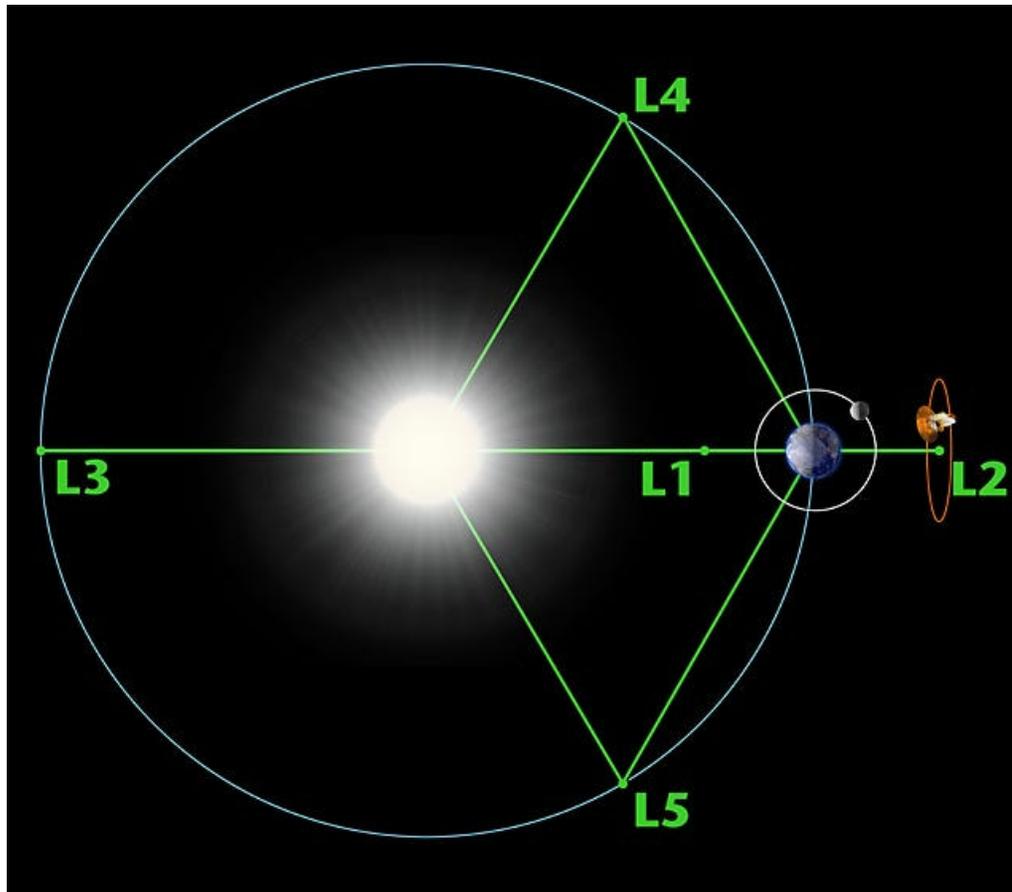
- **Introduction**
- **The MAP environment during the anomaly**
- **Anomaly Analysis**
- **Space weather monitoring and forecast**
- **Conclusion**

Introduction



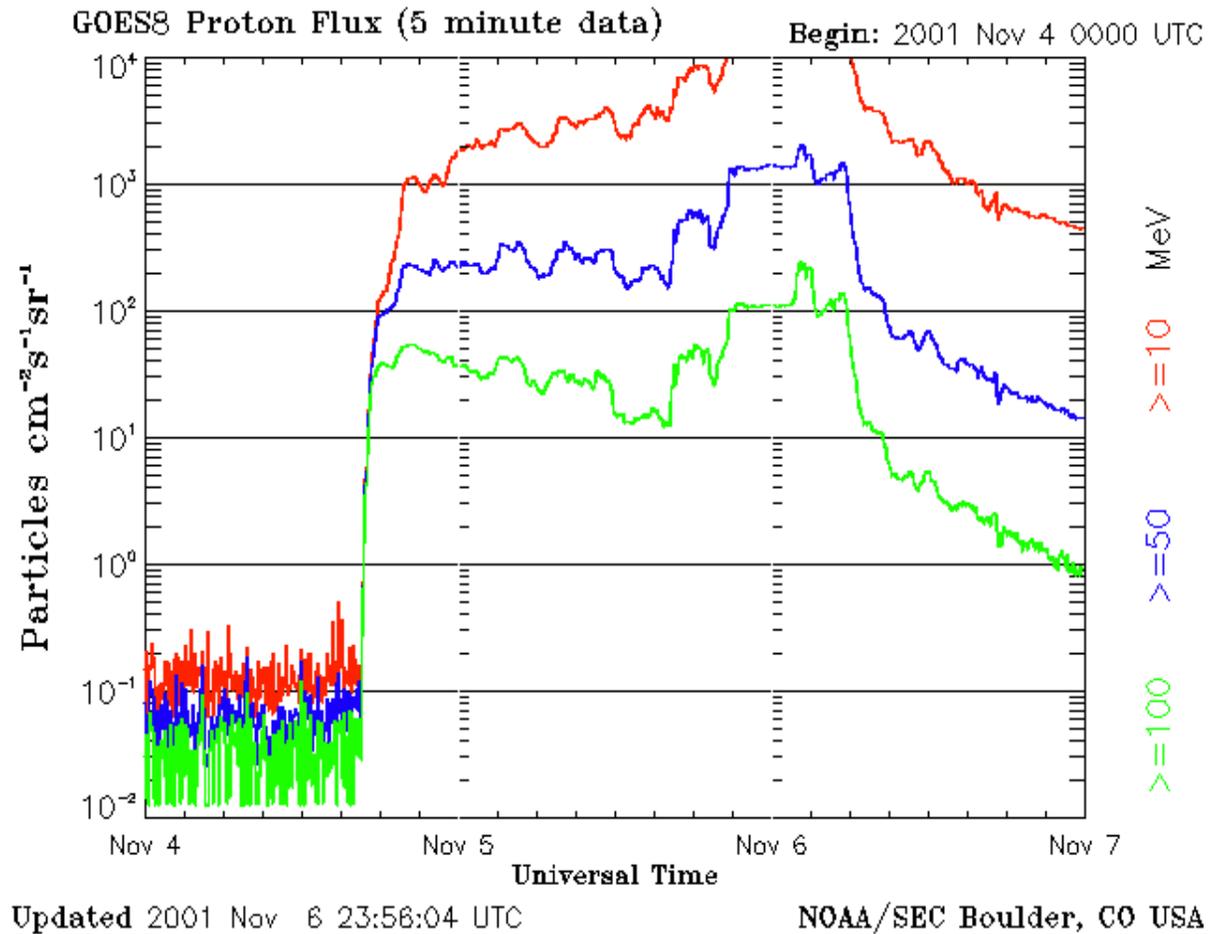
- **Launched June 30, 2001.**
 - **Had phasing orbits prior to insertion in final orbit.**
- **Reached its final position on L2 end of September, 2001.**
- **An event occurred causing a reset of spacecraft processor on November 5, 2001.**

MAP Radiation Environment



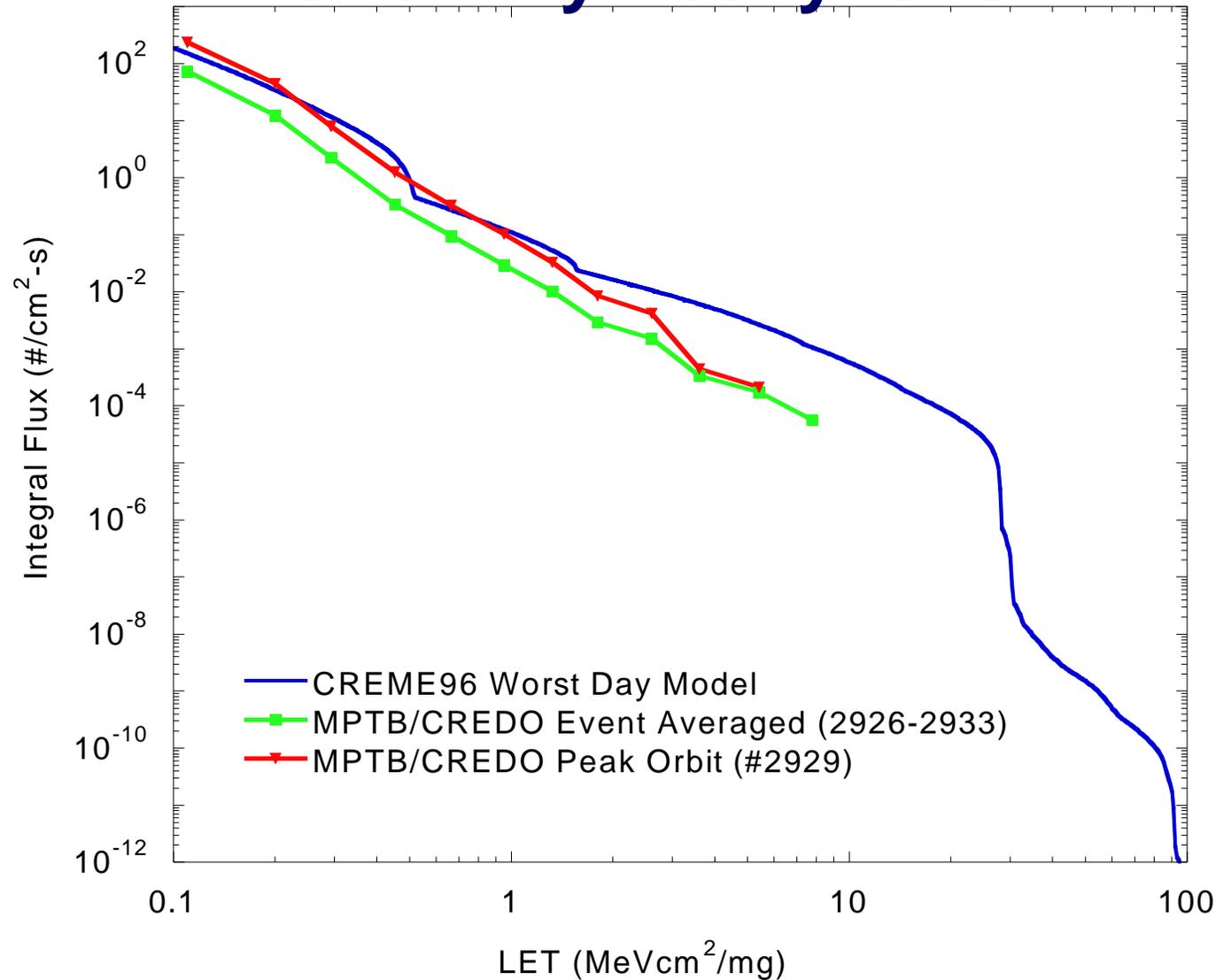
- Potential anomaly inducing environment
 - GCR
 - Solar Particles

Environmental activity during the anomaly-protons



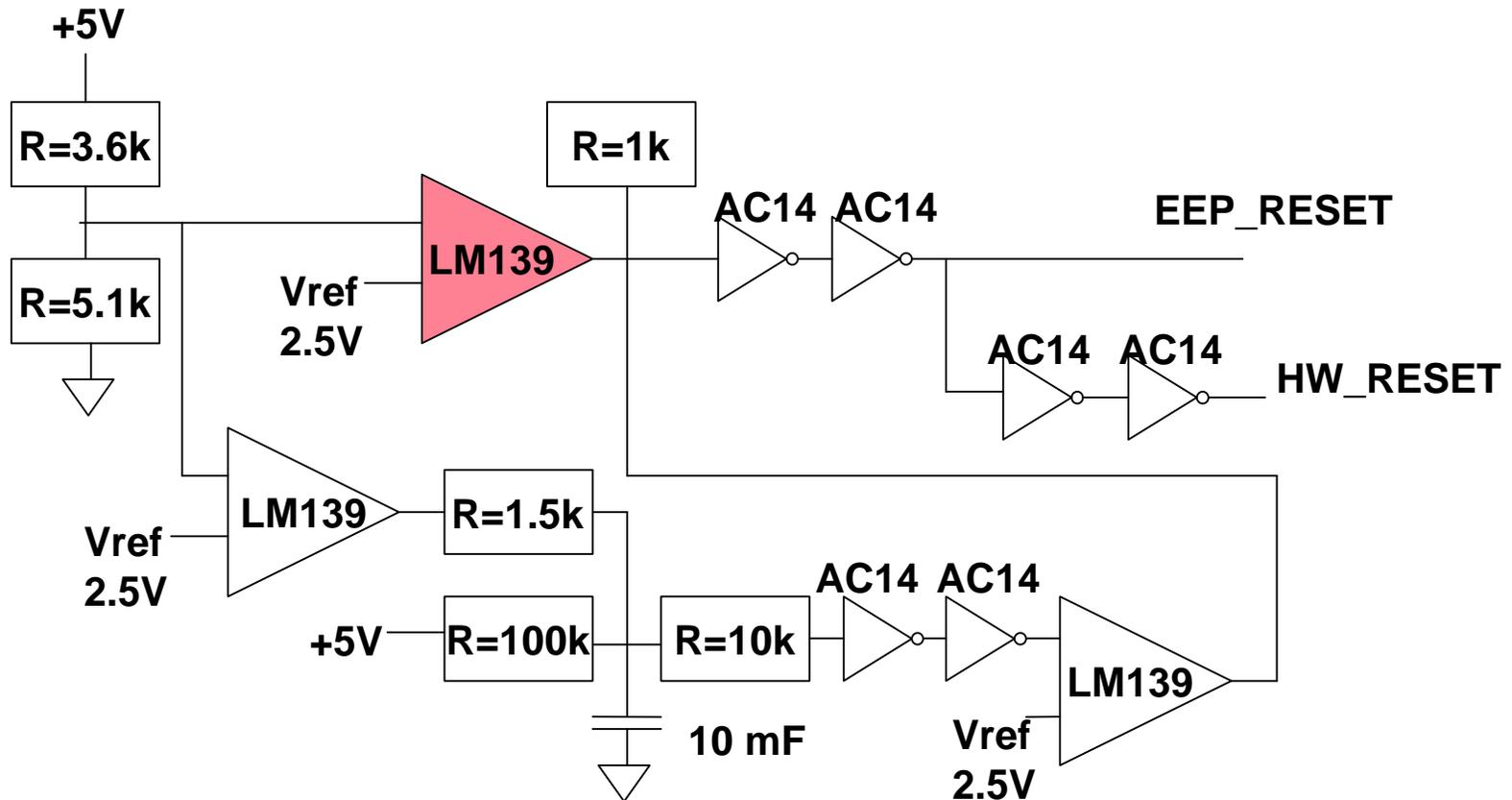
Data from NOAA/SEC/SWO, <http://sec.noaa.gov>

Environment activity during the anomaly-heavy ions

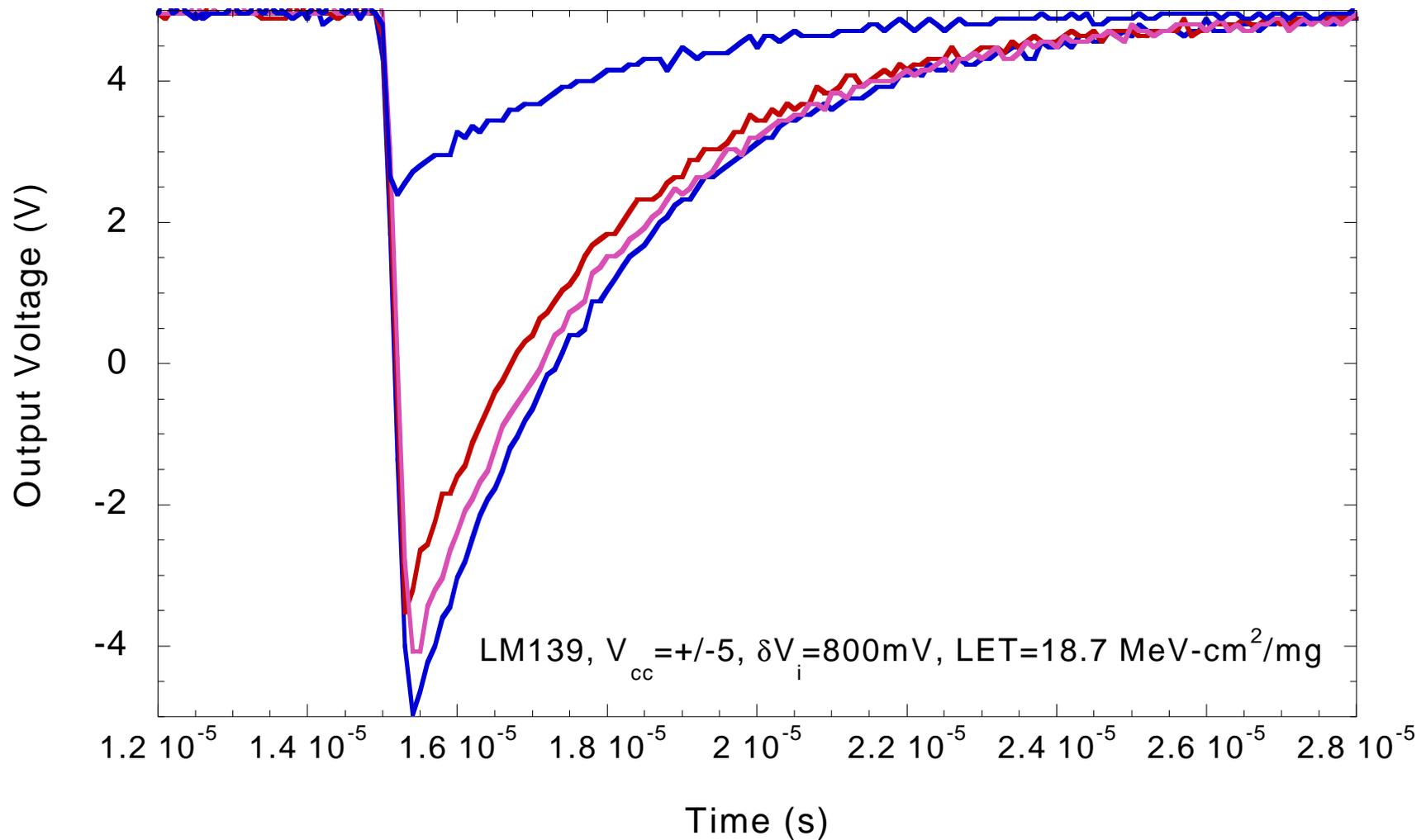


After C. Dyer & al., presented at NSREC 2002

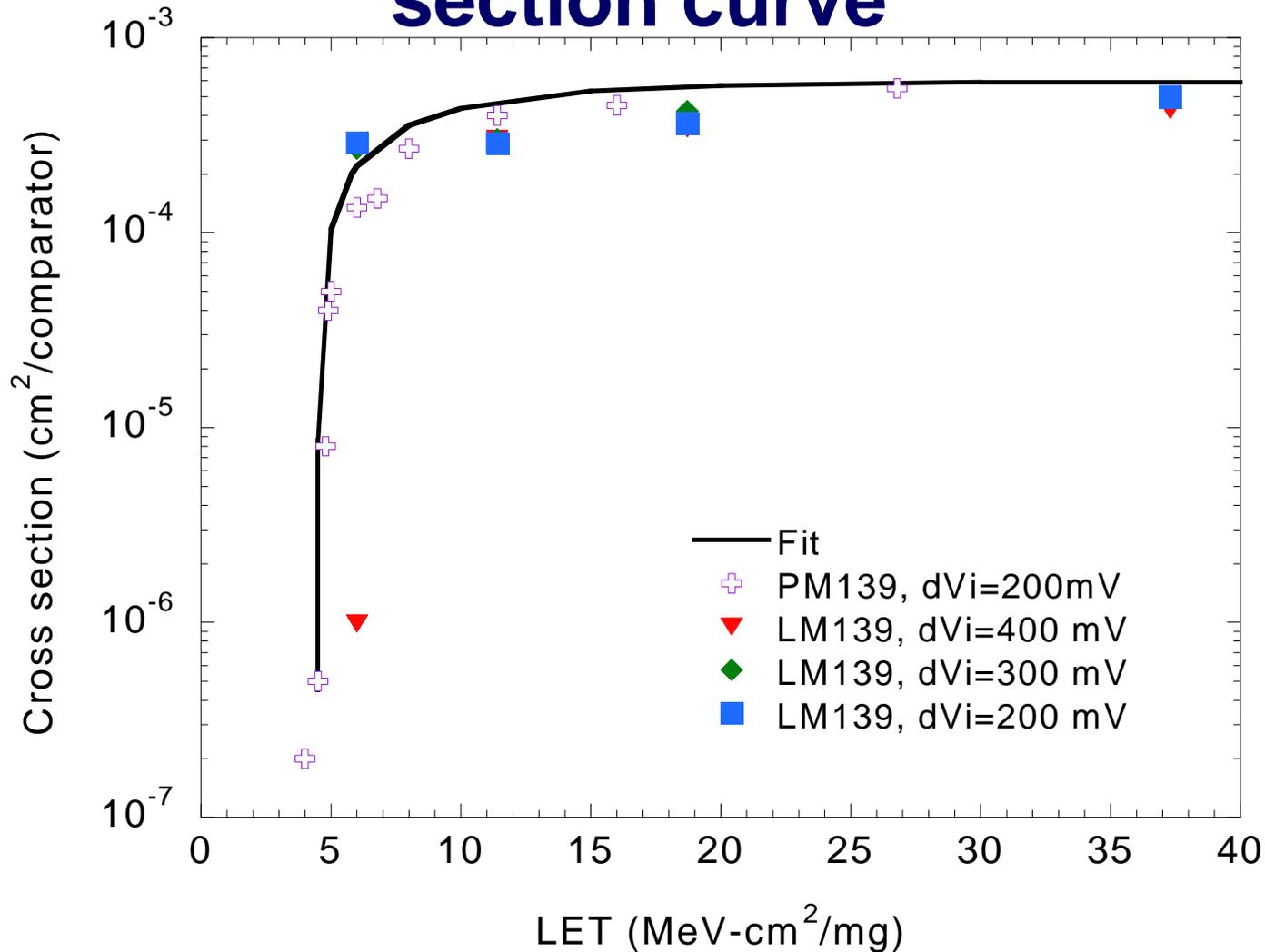
Anomaly analysis- sensitivity of design



PM139/LM139 - typical Single Event Transient (SET) shape



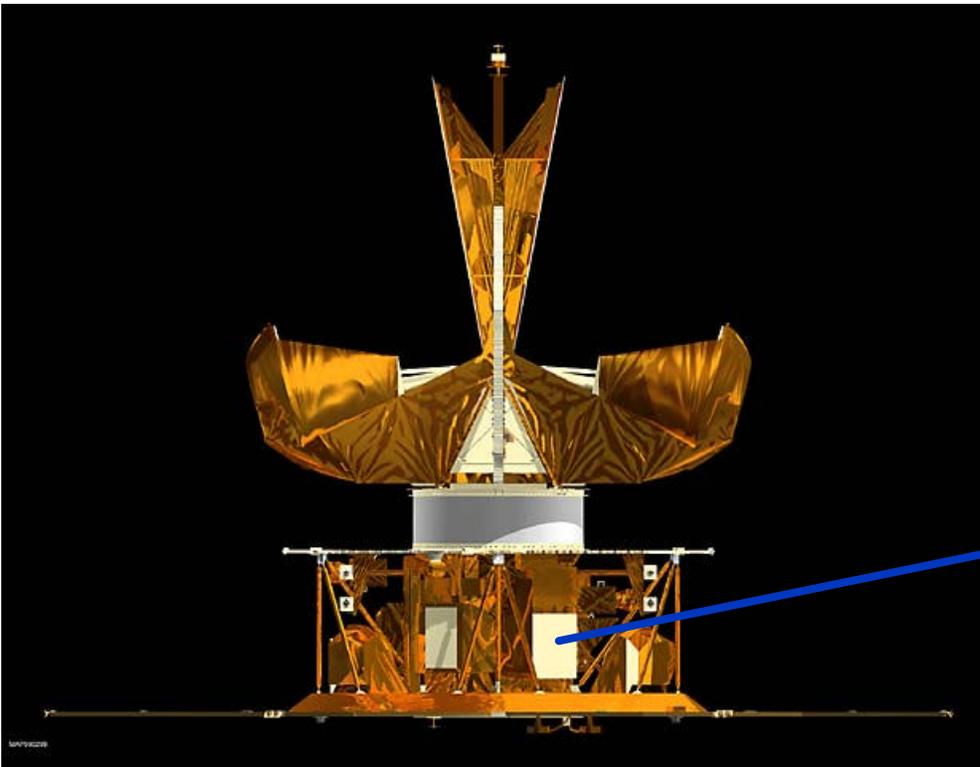
PM139/LM139 heavy ion SET cross section curve



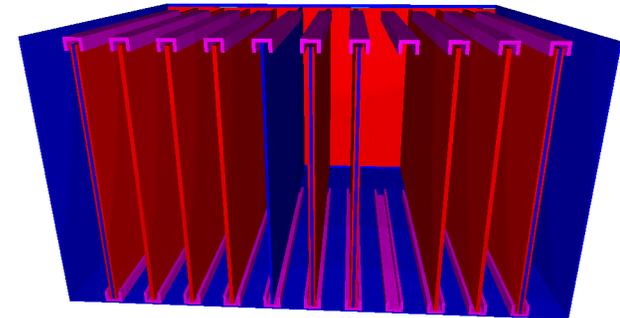
PM139 data after A. Johnston & al., IEEE Trans. On Nucl. Sci., vol. 47,n^o6, Dec. 2000

Shielding Assumptions

Based on total dose analysis, shielding on the Control & Data Handling processor board is equivalent to 500 mils (12.7 mm) of aluminum shielding



C&DH box



SET Rates on L2

Sensitive volume thickness (mm)	GCR SET rate CREME96, solar maximum (event/comparator-day)	Solar Event CREME96, worst day (event/comparator-day)
10	1.8E-3	5.1E-1
15	1.7E-3	3.0E-1
20	1.6E-3	1.8E-1
30	1.5E-3	6.5E-2
40	1.3E-3	4.4E-2
60	9.9E-4	3.4E-2

No other anomaly has occurred since November 5, 2001.

Space Weather Monitoring and Forecasts

- NOAA Space Environment Center (SEC) Space Weather Operations branch (SWO)

- <http://sec.noaa.gov/>

- issues warning and alerts on space weather

- Solar radiation storm criteria

- >10 MeV solar protons fluxes

- warning: flux > 10 p/s-sr-cm² expected

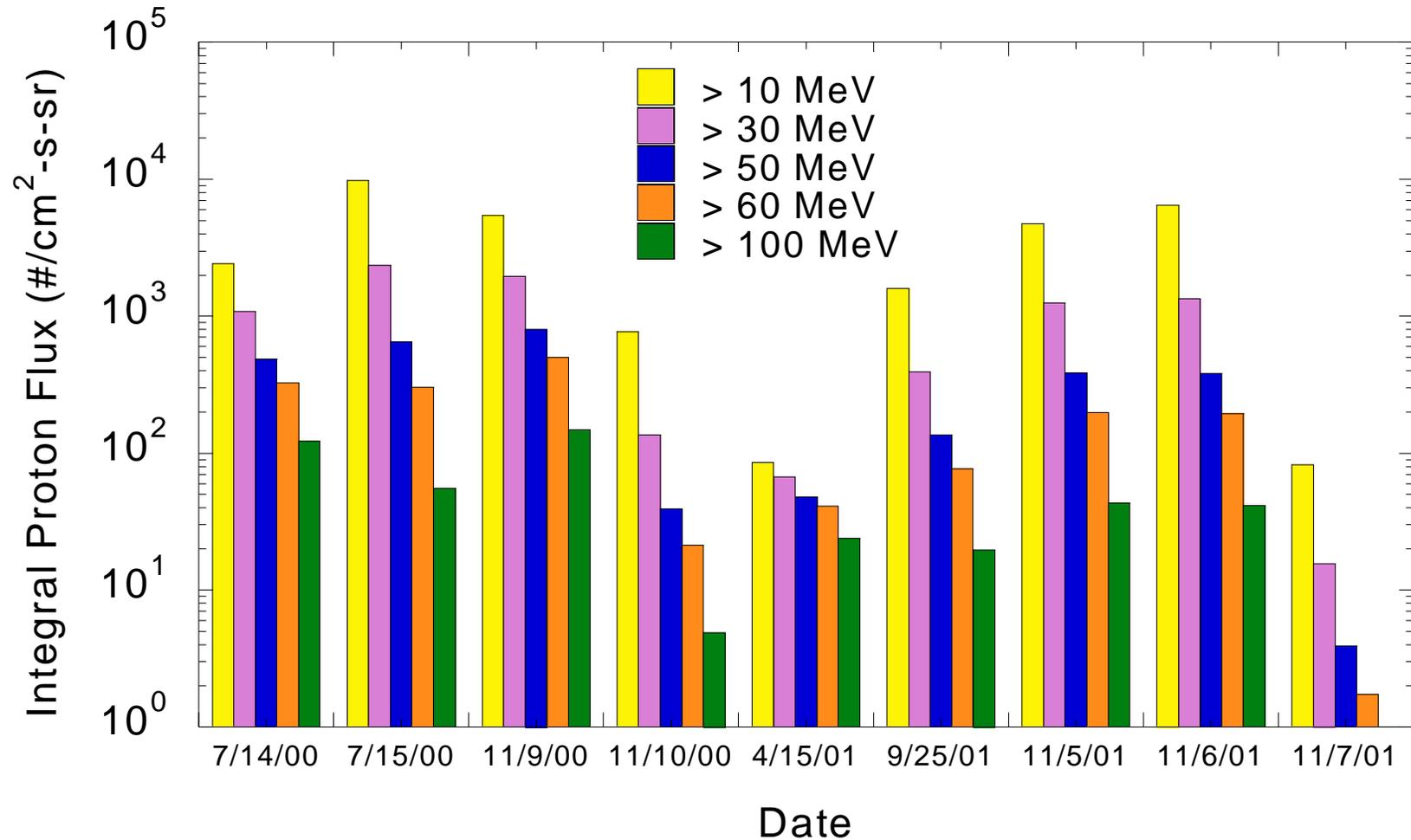
- alert: flux > 10 p/s-sr-cm² Minor
 - flux > 100 p/s-sr-cm² Moderate
 - flux > 1000 p/s-sr-cm² Strong
 - flux > 10,000 p/s-sr-cm² Severe
 - flux > 100,000 p/s-sr-cm² Extreme

- >100 MeV solar protons fluxes

- warning: flux > 1 p/s-sr-cm² expected

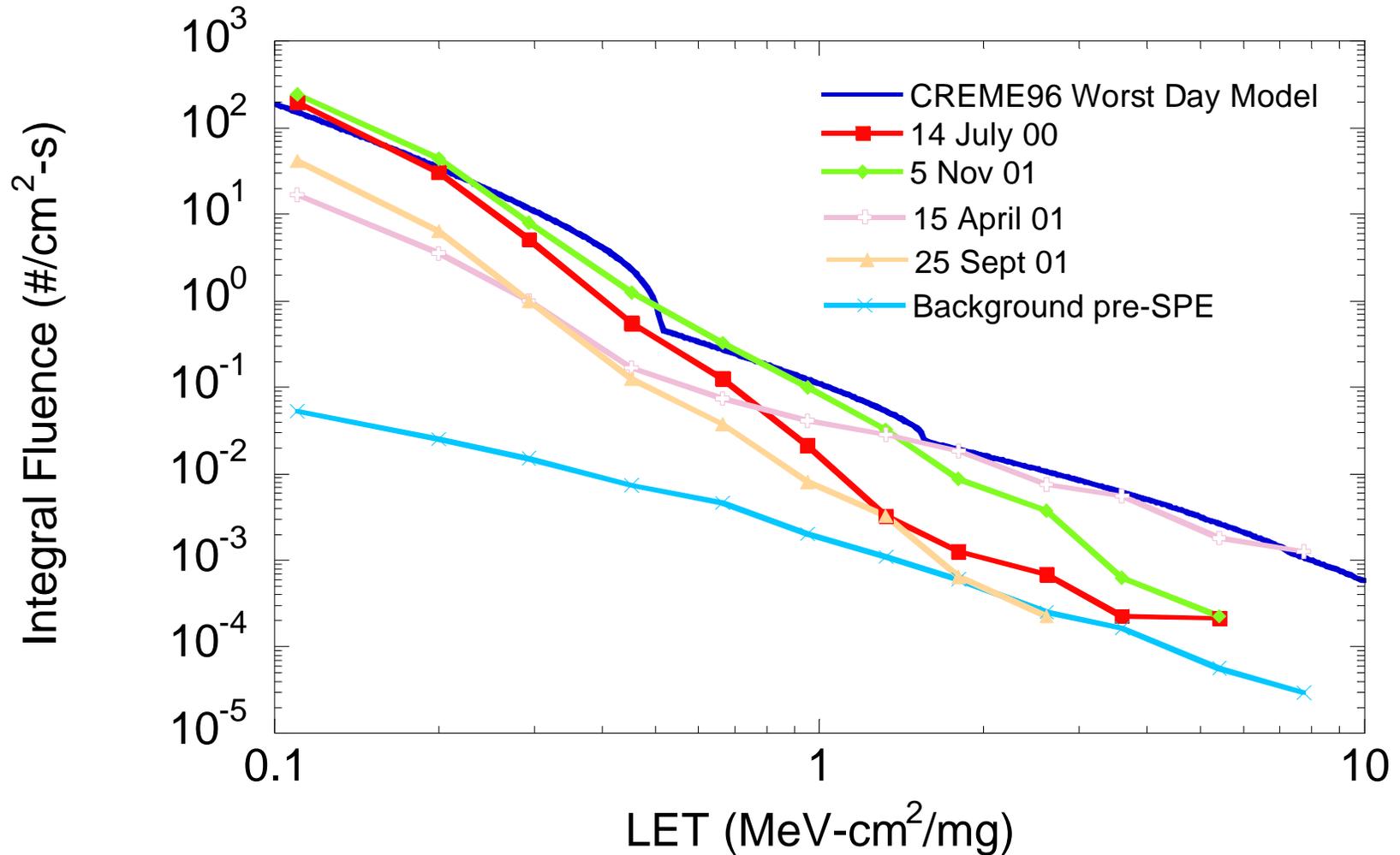
- alert: flux > 1 p/s-sr-cm²

Solar Events Proton Fluxes



Data from NOAA, <http://spidrdev.ngdc.noaa.gov>

SPE Heavy Ion LET Spectra



After C. Dyer & al., presented at NSREC 2002

Conclusion

- **A solar heavy ion induced SET on a PM139 is the probable cause for the anomaly, but a GCR induced SET can not be discounted.**
- **The accuracy of SET rate prediction in linear devices still need to be improved.**
- **Measurements from the CREDO LET instrument on MPTB have been very useful for identifying the cause of the reset.**
- **This anomaly demonstrates the need for accurate space weather information including high energy solar heavy ions.**

Acknowledgment

The authors thank Clive Dyer and Art Campbell for providing the MPTB/CREDO3 data during the MAP anomaly analysis.

Backup slides

